GEOMATRIX

INTERIM REMEDIAL MEASURE ANALYSIS OF ALTERNATIVES AND WORK PLAN FOR DESIGN

Former McKesson Facility
9005 Sorensen Avenue
Santa Fe Springs, California

Prepared for

McKesson Corporation
One Post Street, Suite 2850
San Francisco, CA

June 1995
Project 2282

Geomatrix Consultants

TABLE OF CONTENTS

EXECUTIVE SUMMARY

This report presents the evaluation of alternatives and a work plan for the design of an interim remedial measure (IRM) for groundwater at the former McKesson Chemical Company facility at 9005 Sorensen Avenue in Santa Fe Springs, California. This report has been prepared by Geomatrix Consultants, Inc. (Geomatrix) on behalf of the McKesson Corporation (McKesson). The work is being conducted pursuant to Consent Order No. 89/90-007 issued to McKesson by the California Environmental Protection Agency, Department of Toxic Substances Control (DTSC) on 8 January 1990.

The objective of the report is to present a summary of background information relevant to the development of an IRM, describe the objective and alternatives considered for a groundwater IRM, and present the results of a preliminary evaluation of containment, treatment, and discharge alternatives appropriate to accomplish the IRM objective. The report also presents a work plan and schedule for the design of the IRM.

The site consists of 4.3 acres at which McKesson operated a bulk chemical repackaging facility from 1976 to 1986. Facility operations ceased in 1986 and the site has remained inactive. The site is located in an area of heavy industrial use. The Remedial Investigation, conducted by Harding Lawson Associates, indicated the presence of halogenated and non-halogenated volatile organic compounds (VOCs) in soil and groundwater at the site. The highest concentrations of VOCs in soil occur in the vicinity of the former solvent above-ground storage tank (AST) area. Elevated concentrations of VOCs in groundwater occur downgradient of the former solvent AST area; elevated concentrations of VOCs also occur in groundwater at the upgradient site boundary and at the upgradient adjacent property (Angeles Chemical Company). A Remedial Action Plan for site soil has been developed and implemented by Geomatrix. Remediation of soil in the former solvent AST area using a soil vapor extraction and treatment system (SVE) has been on-going since March 1994.

The groundwater IRM was proposed by McKesson in lieu of additional investigation work requested by DTSC in October 1994. McKesson reasoned that an IRM was the most effective use of resources at this time; DTSC agreed with this proposal. The objective of the groundwater IRM is to contain groundwater affected by VOCs downgradient of the former solvent AST area. Several containment alternatives were considered that would meet the IRM objective, including:

(1) a hydraulic barrier at the downgradient edge of the site, created by conventional groundwater extraction with onsite treatment and offsite discharge of treated groundwater;

(2) a physical barrier enclosing a portion of the site (e.g., slurry wall), with limited groundwater extraction internal to the wall, onsite treatment and offsite discharge of treated water; and

(3) a hydraulic barrier or cell enclosing a portion of the site, created by groundwater extraction at the downgradient property boundary, treatment, and reinjection of treated groundwater near the upgradient property boundary.

These alternatives were discussed with DTSC in January and February 1995, and DTSC informed McKesson that it would not approve any alternative involving an upgradient hydraulic or physical barrier. Therefore, conventional groundwater extraction and treatment (alternative 1) is the only acceptable alternative for containment at the site.

Preliminary computer simulations based on estimated hydraulic parameters for the site indicated that an extraction rate of 50 gallons per minute will achieve the containment objective. The actual extraction rate required to achieve containment will be based on results of aquifer tests that will be conducted during the next phase of work.

An evaluation of technologies appropriate to treat the groundwater extracted during the IRM identified three viable alternatives: (1) elevated temperature air stripping, (2) two air strippers in series, or (3) a combination of air stripping and UV oxidation. Each of these alternatives would require treatment of an off-gas stream by resin adsorption, catalytic oxidation, or flameless oxidation. The groundwater and off-gas treatment alternative will be selected during the design phase, and will be based on results from the aquifer tests and negotiations regarding effluent concentration limits.

An evaluation of options for the discharge of treated groundwater indicated that the most viable options are discharge to the storm drain system or discharge to the sanitary sewer system. A selection of one of these two options will be made during the design phase, and will be based on approval of the discharge option and effluent limits by the appropriate regulatory agencies.

The work plan describes activities to be conducted during the design of the IRM. These activities include sampling of existing groundwater monitoring wells, the installation and testing of a new groundwater extraction well, and final selection and design of the groundwater treatment and discharge systems. The scope and schedule presented for the design phase culminates in the delivery of a design report to DTSC in December 1995. The design report will document the test results, final design basis, and overall system designs.

INTERIM REMEDIAL MEASURE
ANALYSIS OF ALTERNATIVES AND
WORK PLAN FOR DESIGN

Former McKesson Facility
9005 Sorensen Avenue
Santa Fe Springs, CA

1.0 INTRODUCTION

This report presents the evaluation of alternatives and a work plan for the design of an interim remedial measure (IRM) for groundwater at the former McKesson Chemical Company facility at 9005 Sorensen Avenue in Santa Fe Springs, California (the site; Figure 1). The evaluation was performed on behalf of the McKesson Corporation (McKesson) by Geomatrix Consultants, Inc. (Geomatrix). The work is being conducted pursuant to Consent Order No. 89/90-007 issued to McKesson by the California Environmental Protection Agency, Department of Toxic Substances Control (DTSC) on 8 January 1990. Soil and groundwater at the site are affected by volatile organic compounds (VOCs). McKesson has implemented soil remediation activities since March 1994 pursuant to the approved "Remedial Action Plan for Onsite Soil" (Geomatrix, 1993a).

On 20 October 1994, DTSC issued a letter to McKesson requesting investigation of groundwater quality downgradient of the site (DTSC, 1994). During an 18 January 1995 meeting among representatives of McKesson and DTSC, McKesson presented a cross-referenced list and map of 200 potential sources of VOCs within the immediate vicinity (<2 mile radius) of the site, and file information on 17 selected sites. The purpose of the information provided to DTSC was to demonstrate that the technical development and interpretation of a downgradient groundwater investigation by McKesson would be complicated and likely inconclusive due to the large number of known and presently unknown additional sources of VOCs to groundwater upgradient and downgradient of the former McKesson site. McKesson proposed that the offsite investigation of groundwater quality be postponed until the regulatory agencies have a better understanding of all potential sources in the area.

To generate the most significant positive effect using available resources, McKesson proposed in the 18 January meeting the immediate development and implementation of an IRM with onsite containment of affected groundwater as the primary goal; DTSC agreed with the proposal at the meeting.

After a number of discussions between McKesson and DTSC regarding conceptual design of the IRM, McKesson issued to DTSC a letter dated 21 February 1995 documenting McKesson's intention to move forward with the IRM design process (McKesson, 1995). McKesson presented a schedule showing the submittal of the IRM alternatives evaluation and work plan (this report) on 1 June 1995.

1.1 OBJECTIVE AND SCOPE

The objective of this report is to present a summary of background information relevant to the development of an IRM, describe the objectives and alternatives considered for a groundwater IRM, and present the results of a preliminary analysis of containment, treatment and discharge alternatives appropriate to accomplish the IRM objective.

This report also presents a work plan and estimated schedule developed for the design of the IRM. Additional hydrogeologic, chemical, and engineering data are required prior to the completion of a design. The work plan and schedule are presented to describe how and when these data will be obtained.

2.0 BACKGROUND

This section presents background information about the site and its vicinity that is relevant to the presence of VOCs in groundwater and the development of the IRM. This information includes a description of the site and its historical use, a summary of regional and local hydrogeology, a summary of the distribution of VOCs in soil and groundwater, and a discussion of current site soil remediation efforts.

2.1 SITE DESCRIPTION AND USE

The former McKesson facility ("site") consists of 4.3 acres located at 9005 Sorensen Avenue in Santa Fe Springs, Los Angeles County, California (Figure 1). The site lies about 2 miles east of the San Gabriel River and the San Gabriel River Spreading Grounds and about ½-mile north of the Santa Fe Springs Oil Field in an area of heavy industrial use, including chemical manufacturing and distribution. Adjacent features and properties include: to the north, an unlined drainage channel, a Southern Pacific Transportation Company railroad easement, and the Angeles Chemical Company bulk chemical packaging facility at 8915 Sorensen Avenue; to the east, Sorensen Avenue; to the south, Trucking Unlimited at 9215 Sorensen Avenue; and, to the west, a Liquid Air Corporation facility.

The historical use of the site was described in the Remedial Investigation Report [RI report; Harding Lawson Associates (HLA), 1992]. The following summary of site use is based on information presented in earlier reports.

The site was undeveloped before 1975, although the railroad north of the site was active before 1927. A bulk chemical repackaging facility was operated at the site by McKesson Chemical Company from 1976 to 1986. Facility operations ceased in 1986 and the site has remained inactive. In 1990, selected structures, aboveground storage tanks (ASTs), loading platforms, and a drum-wash shed, were demolished. Some structures related to the former use as a bulk chemical repackaging facility, including 21 underground storage tanks (USTs), remain at the site. Figure 2 presents existing features on the site plan.

The site is currently unoccupied, except for the remediation equipment described in Section 2.4. The site is mostly paved with asphalt, with some concrete loading ramps, pads and berms still in place. A 6-foot-high chain link fence surrounds the rear of the property, and entrance from Sorensen Avenue is through a locked chain link gate. An automatic security system has been installed in the areas that are used for the current soil remediation activities, and site visitors must enter a code to disarm the system upon entering the rear of the property.

Two buildings remain onsite: one approximately 12,000-square-foot concrete masonry unit structure, and one 150-square-foot yard office near the rear of the property which is being used by the existing remediation equipment.

Utility service is available at the site and partially active. Municipal water is metered and used by an underground irrigation system to maintain landscaping along the property frontage on Sorensen Avenue. Underground municipal water pipelines that serve the rear of the property are inactive. Electrical service at 230 volt, 200 amps is available near the yard office. Sanitary sewer pipelines are located on the east side of the site beneath Sorensen Avenue. Surface water drains northeast into the unlined drainage channel along the north side of the property.

2.2 SUMMARY OF HYDROGEOLOGY

The regional and project area geology/hydrogeology have been described in the RI report (HLA, 1992). The following summary of the geologic and hydrogeologic setting is based on data and conclusions presented in earlier reports and data gathered by Geomatrix in 1994. This summary is provided to form the basis for the conceptual model of the groundwater flow system at the site, which is necessary for development of the groundwater IRM.

2.2.1 Regional Geological and Hydrogeological Setting

The site is located on the Santa Fe Springs Plain, a gently rolling physiographic feature within the Los Angeles Coastal Plain (Coastal Plain), south of the Puente Hills and east of the San Gabriel River (Figure 3). This area has a semi-arid Mediterranean-type climate where the annual rainfall averages about 15 inches and most of the rainfall occurs between the months of October and April.

The Coastal Plain is underlain by a sequence of alluvial sediments near the foothills and interfingering marine sediments that thicken toward the Pacific Ocean. The Coastal Plain lies within the northwest portion of the Peninsular Range geomorphic province, which consists of northerly to northwesterly trending mountain ranges and intervening valleys. It is bordered by the bedrock Puente and Merced Hills to the north and east. The alluvial fan and shallow marine sediments of the Coastal Plain slope gently toward the Pacific Ocean except where broken by a series of low hills along the Newport-Inglewood Uplift.

Three rivers, the San Gabriel, Rio Hondo, and Los Angeles, drain the Coastal Plain, which is part of the San Gabriel River watershed. The former two rivers flow into the Coastal Plain from the San Gabriel Valley through a gap in the Merced and Puente Hills known as the Whittier Narrows.

The Coastal Plain is divided into four groundwater basins. The Santa Fe Springs Plain area lies within the Central Basin (Figure 3). The hydrogeology of the Central Basin has been extensively documented as a result of groundwater basin adjudication required by a 1965 Superior Court judgment (California Department of Water Resources, 1991). In 1991, the judgment was amended to provide exemptions for extraction of affected groundwater (California Department of Water Resources, 1994).

The hydrogeology of the Central Basin in the Santa Fe Springs Plain area is characterized by a series of eight aquifers in the recent alluvium, Lakewood Formation, and San Pedro Formation. The aquifers generally consist of sands and gravels and generally are separated by aquitards consisting of fine-grained sediments. The total thickness of these sediments is about 1400 feet. Figure 4 presents a north to south hydrogeologic cross-section through the Santa Fe Springs Plain area; the location of the section line is presented on Figure 3. Near the site, the shallow aquifers are the Gage, Hollydale, and Jefferson. These three aquifers overlie the deeper and major water-producing aquifers, the Lynwood, Silverado, and Sunnyside. These deep aquifers have been structurally deformed by folding and faulting.

The regional groundwater flow system is generally bounded to the north by the Puente and Merced Hills. Principal areas of recharge include the unlined portions of the Rio Hondo and San Gabriel Rivers, and the spreading grounds adjacent to these rivers used for artificial recharge operations, and possibly the Puente and Merced Hills. The area of recharge for the deeper aquifers generally corresponds to the Central Basin Non-Pressure Area (Figure 3) where the deeper aquifers are relatively shallow and can be recharged by vertical seepage from the shallow aquifers. Additionally, some groundwater inflow occurs from the San Gabriel Basin through the gap at Whittier Narrows. Recharging water tends to moves downward and then groundwater flow is lateral toward the Pacific Ocean and the West Coast Basin. Most of the groundwater pumping throughout the Central Basin occurs from wells completed in the deeper aquifers.

Published potentiometric maps for the deep aquifers for Fall 1993 (Los Angeles County Department of Public Works, 1993) and January 1995 (Water Replenishment District of Southern California, 1995) confirm that the potentiometric surface slopes away from the San Gabriel River, at a gradient of approximately 0.004 foot per foot.

2.2.2 Site Hydrogeology

The project area geology and hydrogeology have been described in the RI report (HLA, 1992). The following summary of stratigraphy and the occurrence and movement of groundwater is based on data and conclusions presented in earlier reports and potentiometric data collected by Geomatrix in 1994.

The stratigraphic interpretations are based primarily on boring logs that were advanced to depths ranging between 30 to 140 feet during previous investigation activities. Based on these lithologic data, the project area is underlain by a sequence of silt and clay, silty sand, and sand to a depth of at least 140 feet. The coarse-grained water-yielding units appear to be contained within three zones that are termed herein as the perched zone, the A zone (divided into the A_1 and A_2 zones), and the B zone. These zones may be correlative with the Gage, Hollydale, and Jefferson aquifers that are presented on Figure 4. The fine-grained units that separate the coarse-grained units consist of silt and clay.

The upper sand that occurs between 15 and 30 feet below ground surface (bgs) locally contains perched water. This zone is referred to in this document as the perched zone and water is likely present at the base of this zone seasonally during periods of high rainfall. Underlying the silt and clay aquitard below the perched zone is a saturated coarse-grained unit that occurs between about 50 and 120 feet bgs. This coarse-grained unit consists of two sands, each about 30 feet thick, that are separated by about 15 feet of mixed silty sand and silt and clay. This unit is referred to as the A zone, and the upper and lower sands are referred to as the A_1 and A_2 zones, respectively. One boring at the site penetrated a 10-foot thick silt and clay unit underlying the A_2 zone and terminated in the underlying sand unit. The lower sand is referred to as the B zone.

Most of the monitoring wells at the site are screened within the upper portion of the A_1 zone. Two wells are screened within the perched zone, and four are screened within the A_2 zone. Figure 5 presents the locations of site monitoring wells, and the potentiometric surface of the A_1 zone for 1 February 1994. As shown on the figure, the A zone is confined. Figure 5 shows that the potentiometric surface in the A_1 zone is oriented to the southwest, with an average horizontal hydraulic gradient of about 0.005 foot per foot (ft/ft). This gradient direction and magnitude are consistent with previously collected data, and with data collected by Geomatrix in February 1995. It is unknown if the direction or magnitude of the horizontal hydraulic gradient exhibits seasonal fluctuations; water levels are currently being measured monthly (Section 7.1.2).

Available water-level elevation data from well clusters SB-17/17B/17A and SB-23/23B/23A, after correction for well location relative to horizontal gradient, show little evidence for the presence of a vertical hydraulic gradient at the site. It is unknown if seasonal fluctuations may result in a vertical gradient; long-term water-level data are being collected by automated equipment installed in the SB-17/17B/17A well cluster (Section 7.1.2).

2.3 DISTRIBUTION OF CHEMICALS

The previous investigations conducted at the former McKesson and the immediately adjacent and hydraulically upgradient Angeles Chemical Company (Angeles) facilities have been described in the respective RI reports (HLA, 1992 and SCS Engineers, 1994). The following summary of the previous investigation results, and results of the 1994 groundwater sampling by Geomatrix is provided to form the basis for understanding the distribution of chemicals in soil and groundwater beneath the site and upgradient of the site.

2.3.1 Soil

Soil at the McKesson and Angeles sites has been investigated for the presence of inorganic and organic chemicals (HLA, 1992; SCS, 1994). As documented in the RI report (HLA, 1992), soil beneath the McKesson site was found to contain chlorinated and non-chlorinated volatile organic compounds (VOCs). The highest concentrations of VOCs in soil were found near the former solvent AST area. Immediately beneath the former solvent AST area, VOC-containing soil extended to groundwater, although the concentrations decreased with depth. Locally, there were some detections of semi-volatile organic compounds and petroleum hydrocarbons.

As documented in the Angeles RI report (SCS, 1994), soil beneath the Angeles site was found to contain chlorinated and non-chlorinated VOCs. Highest concentrations of VOCs in soil were detected at the northeast portion of the railroad spur and the area near the south central drain (Figure 2). Beneath these two areas, VOC-containing soil extends to groundwater.

2.3.2 Groundwater

In February 1994, Geomatrix sampled all of the monitoring wells at the McKesson site; samples were analyzed for VOCs by EPA Method 8240. Table 1 presents a summary of the VOCs detected in groundwater. Figure 6 presents a map of the aggregate VOC concentrations in each monitoring well based on the February 1994 data. As shown on Figure 6, the highest concentrations of VOCs in groundwater at the McKesson site are detected beneath or downgradient of the former solvent AST area. Figure 7 presents a hydrogeologic cross-section through both sites and displays the detected VOCs in groundwater. As shown on Figure 7, the VOCs are mostly limited to the A_1 zone. Figures 6 and 7 both show that VOCs were detected in monitoring wells located upgradient and transgradient of the McKesson site, which indicates contribution from offsite sources.

Groundwater was also sampled from monitoring wells at the Angeles site in February 1994. Seven monitoring wells at the Angeles site were sampled by SCS and analyzed for VOCs by EPA Method 8240. Table 1 presents a summary of the analytical results. Only Angeles wells MW-1, MW-2, and MW-3 are screened in the A_1 zone. Wells MW-4 and MW-6 are installed in the perched zone, and well MW-7 is installed in the aquitard overlying the A_1 zone. As shown on Figures 6 and 7, elevated concentrations of VOCs were detected in samples from all Angeles wells, and are highest in the perched zone wells AMW-4 and AMW-6.

The soil and groundwater data indicate that potential source areas of VOCs to groundwater exist on both the former McKesson and Angeles sites. On the former McKesson site, the former solvent AST area is a potential source of VOCs to the groundwater. On the former Angeles site, at least two potential source areas exist; in the northeastern portion of the site near the railroad spur, and near drain number 2 (Figure 2).

2.4 CURRENT SITE REMEDIATION EFFORTS

Current remediation efforts at the McKesson site have been focused on remediation of onsite soil, with the objectives to (1) reduce concentrations of VOCs in soil to protect groundwater quality, and (2) reduce potential air emissions of VOCs when existing USTs are removed from the site. Based on these objectives, soil near the former solvent AST and UST area is being remediated using a soil vapor extraction and treatment system (SVE).

The remedial actions conducted at the site have been pursuant to the "Remedial Action Plan for Onsite Soil" (RAP; Geomatrix, 1993a), the "Phase I Onsite Soil Remediation Work Plan" (Geomatrix, 1993b), and the "Results of Phase I Activities and Phase II Work Plan for Onsite Soil Remediation" (Geomatrix, 1993c). These reports, which have been submitted and approved by DTSC, describe the design and phased implementation of the SVE system. The design of the system was based on a network of vapor wells intended to influence and extract soil vapors from vadose zone soil in the vicinity of the former solvent AST and UST areas. Extracted soil vapors are being treated with a resin bed adsorption unit with onsite regeneration supplied by Purus, Inc. The phased approach to implementation was proposed to expedite start-up, particularly through the South Coast Air Quality Management District (SCAQMD) permitting process, and accommodate the capacity constraints of the treatment unit.

The SVE system was constructed in the first quarter of 1994, and began operating in March 1994. Three vapor wells (E-1, SB-37, and V-1) were piped up to the extraction and treatment system as shown in Figure 8. Lines from each of the vapor wells were manifolded together so that all of the wells can be used for either extraction of soil vapors or reinjection of treated gases. Since startup, soil vapor has been extracted only from well E-1, which was selected as the extraction well because it is located in the area of highest VOC concentrations in soil vapor.

Over 2000 gallons of product (approximately 20,000 lbs) has been recovered by the treatment unit and destroyed offsite since startup of the SVE. Aggregate VOC concentrations in the extracted soil vapor were reduced from approximately 35,000 ppmv to 5000 ppmv in the first seven months of system operation (Figure 9).

In December 1994, a revised air permit was received from the SCAQMD which allowed higher extraction flow rates and discharge of treated soil vapor to the atmosphere. After piping modifications, the flow rate of the extracted soil vapor from E-1 was increased in February 1995. As expected, with the increase in flow rate, new areas around the extraction well were influenced, and VOC concentration in the extracted soil vapor rose to approximately 11,000 ppmv (Figure 9).

Planned SVE operations call for continued increases in the flow rate of soil vapor as VOC concentrations fall, in accordance with the SCAQMD air permit and the capacity of the treatment unit. Measurements of the radius of influence obtained during operation of the SVE are planned to check the original design basis, to optimize future extraction flows, and to evaluate whether additional extraction wells are required to achieve remediation objectives.

3.0 IRM OBJECTIVE AND ALTERNATIVES SCREENING

This section presents the objective for the groundwater IRM and discusses the various alternatives that were evaluated to achieve the IRM objective.

3.1 IRM OBJECTIVE

The objective of the IRM is to contain groundwater affected by VOCs downgradient of the former solvent AST area.

3.2 IRM ALTERNATIVES SCREENING

Geomatrix preliminarily evaluated the feasibility of several containment alternatives that would meet the IRM objective, including:

(1) a hydraulic barrier at the downgradient edge of the site, created by conventional groundwater extraction with onsite treatment and offsite discharge of treated groundwater;

(2) a physical barrier enclosing a portion of the site (e.g., slurry wall), with limited groundwater extraction internal to the wall, onsite treatment and offsite discharge of treated water; and

(3) a hydraulic barrier or cell enclosing a portion of the site, created by groundwater extraction at the downgradient property boundary, treatment, and reinjection of treated groundwater near the upgradient property boundary.

In addition to achieving the containment goal, alternatives 2 and 3 also provide the desirable effect of hydraulically isolating the McKesson site from further contribution of VOCs from upgradient sources by creating a barrier to flow entering the site. All three alternatives are judged to be feasible.

Geomatrix and McKesson discussed these alternatives in a conceptual manner with DTSC during the 18 January 1995 meeting. At that time, McKesson expressed a preference for an alternative that provided hydraulic isolation of the site. After the meeting, DTSC informed McKesson that it would not approve any alternative involving an upgradient hydraulic or physical barrier (DTSC, 1995). Therefore, conventional groundwater extraction and treatment is the only acceptable alternative for containment at the site. Due to the lack of an upgradient barrier, this alternative will also provide containment and treatment for a relatively large volume of VOC-affected groundwater that originates offsite. McKesson may consider several administrative or legal approaches to address the issue of VOC contribution from offsite sources; however, such approaches are not developed or presented within this report.

Discussions of the groundwater extraction component, treatment technologies, and water discharge options for the selected alternative are presented in the following sections.

4.0 GROUNDWATER EXTRACTION EVALUATION

This section describes the groundwater extraction component of the IRM, including lateral and vertical containment requirements, a preliminary estimate of aquifer transmissivity, and results of modeling used to estimate the pumping rate required to achieve the intended zone of containment.

4.1 CONTAINMENT REQUIREMENTS

As discussed in Section 3, conventional groundwater extraction was selected, due to limitations imposed by DTSC, as the alternative to contain groundwater affected by VOCs downgradient of the former solvent AST area. The lateral extent of required containment is based on groundwater flow lines that bound the former solvent AST area. Figure 6 shows the required containment area.

The groundwater chemical analyses indicate that the highest concentration of VOCs in groundwater beneath the site is within the A_1 zone, which occurs between depths of approximately 50 and 80 feet bgs (Figure 7). The available hydrogeologic data and the vertical distribution of VOCs in groundwater suggest that horizontal groundwater flow is predominant at the site. Based on these data, containment of groundwater to a depth of approximately 80 feet (base of A_1 zone) is sufficient to achieve the IRM objective.

4.2 ESTIMATION OF TRANSMISSIVITY

Estimates of transmissivity (hydraulic conductivity times thickness) of the A_1 zone beneath the site are required to estimate the rate of groundwater extraction necessary to achieve containment. To assess the range of transmissivities expected for the A_1 zone, results from previous aquifer tests at the site (HLA, 1992) and at the Southern California Chemical facility (Kleinfelder, 1986) were reviewed. The Southern California Chemical facility is approximately 1000 feet northwest of the site. In addition, lithologic logs of borings from the Southern California Chemical facility, the McKesson site, and the adjacent Angeles site were reviewed.

Short-term aquifer testing was conducted in February 1991 by HLA at onsite wells SB-17 and SB-23. Response in deeper wells was negligible. HLA determined that the test results were inconclusive and did not report estimates of A_1 zone transmissivity. Our analysis of the recovery data using the Theis recovery method (Theis, 1935) gives a range of estimates of transmissivity for the screened portion of the A_1 zone (the upper 20 feet) of 1350 to 1600 ft^2/day. Dividing by the screen length of 20 feet gives estimates for hydraulic conductivity between 65 and 80 ft/day. In addition, the drawdown in the pumping well can be used to provide a rough estimate of local transmissivity by using an empirical relationship between drawdown, extraction rate, and transmissivity (Driscoll, 1986).

Based on the drawdown and pumping rate for the tests performed by HLA, the transmissivity of the upper 20-foot portion of the A_1 zone in the vicinity of SB-17 and SB-23 is estimated by empirical means to be approximately 1500 ft^2/day. For the screened interval thickness of 20 feet, the corresponding estimate of hydraulic conductivity is 75 ft/day. We emphasize, however, that single-well aquifer tests, for which drawdown is monitored only in the pumped well, are of limited value because they only provide estimates of hydraulic parameters in the immediate vicinity of the pumped well and are significantly impacted by well efficiency.

Aquifer testing of the A_1 zone that included measurement of drawdown response in observation wells was conducted at the Southern California Chemical facility approximately 1000 feet northwest of the site (Kleinfelder, 1986). The extraction and observation wells had 30-foot-long screens completed across most of the A_1 zone. The average estimated transmissivity, determined from analyses of the aquifer testing results, was 5350 ft^2/day (Kleinfelder, 1986); for a nominal thickness of 35 feet, the corresponding estimate of hydraulic conductivity for the A_1 zone is 153 ft/day, twice that of the McKesson site results.

Based on our evaluation of aquifer testing results, and review of lithologic logs, we estimate that a likely range of transmissivity for the A_1 zone beneath the site is 2000 to 5000 ft^2/day. For model simulations of containment, we have used a transmissivity of 4000 ft^2/day, which we consider to be a reasonable conservative estimate appropriate for the purpose of this report.

4.3 CONTAINMENT SIMULATIONS

A model was developed to simulate groundwater flow in the A_1 zone and evaluate containment provided by groundwater extraction. The simulations were run using TWODAN (Fitts, 1992; 1994), which is a program for modeling two-dimensional groundwater flow using the "analytic element method" described by Strack (1989).

The flow model developed to evaluate groundwater extraction for the site represents the A_1 zone as a confined aquifer with uniform transmissivity of 4000 ft^2/day. Assigned model parameters were based on potentiometric surface maps, lithologic logs of borings, evaluation of aquifer test results, and assessment of regional hydrogeology. For non-pumping conditions, a gradient of 0.005 towards 29° southwest was specified, which is consistent with the February 1994 potentiometric surface. Vertical flow in the A_1 zone during pumping is considered negligible because its horizontal extent is much greater than its thickness, and the screened interval of simulated extraction wells are fully penetrating. Local recharge to the A_1 zone is expected to be minimal because most of the surface in the site vicinity is paved, and a clayey aquitard overlies the A_1 zone. Accordingly, recharge was not directly included in the model.

Flow path simulations indicate that an extraction well screened across the A_1 zone near the southwest (downgradient) boundary of the site can prevent groundwater containing VOCs downgradient of the former solvent AST area from migrating beyond the site. For the assumed model parameters, an extraction rate of 50 gpm achieves the containment objective with a large margin of safety. Figure 10 shows the location of the modeled extraction well, and the simulated potentiometric head and zone of groundwater containment provided by extraction of 50 gpm from the A_1 zone. We emphasize that the extraction rate of 50 gpm is a function of the nominal transmissivity of 4000 ft^2/day used for the containment simulations. The actual extraction rate required to achieve containment will be based on aquifer testing conducted after an extraction well has been installed at the site. We have shown one extraction well on Figure 10 for display purposes only. The required extraction rate could be accomplished also by pumping a total of 50 gpm from several wells located along the downgradient property boundary.

7.0 ADDITIONAL DATA REQUIREMENTS AND WORK PLAN

During this analysis of IRM alternatives, additional data have been identified that are required before design of an IRM can be completed. These additional data needs have been grouped into three general categories: (1) sampling and analysis of existing monitoring wells, (2) installation and testing of a groundwater extraction well(s), and (3) negotiation of discharge limits and selection of a groundwater treatment option. This section of the report identifies the specific data needed in each category, and discusses how each set of data will be utilized in the IRM design. A work plan and schedule describing how and when these data will be obtained are presented. Lastly, the contents of the design report are described to further define the product that will result from this next phase of work.

7.1 SAMPLING AND ANALYSIS OF EXISTING MONITORING WELLS

This subsection describes the rationale and methods for collecting additional groundwater chemistry and water-level data from the existing onsite monitoring wells.

7.1.1 Groundwater Chemical Data

To finalize the design of treatment and discharge options, additional groundwater chemical data are required. Existing inorganics data suggest that pretreatment to prevent scaling will be required for the extracted groundwater, and a metals scan is necessary to further evaluate the two discharge options.

To confirm chemical constituents and concentrations in groundwater at the site, Geomatrix will collect samples from all onsite monitoring wells. Samples from all monitoring wells will be analyzed for VOCs by EPA Method 8240; samples from selected wells screened across the A_1 zone will be analyzed also for selected inorganics and Title 22 CAM-17 metals. Selected samples will be analyzed for the following inorganics: bicarbonate as $CaCO_3$, total alkalinity as $CaCO_3$, chloride, nitrogen as nitrate, sulfate, sulfide, phosphate, aluminum, silica, surfactants, calcium, iron, potassium, magnesium, manganese, sodium, ammonium, total dissolved solids, total suspended solids, hardness, conductivity, pH, turbidity, and cation/anion balance. Analyses for inorganics and metals will be performed by appropriate

EPA- or DHS-certified methods that provide detection limits required for evaluation of treatment and discharge alternatives.

Groundwater samples will be collected from site monitoring wells in accordance with Geomatrix protocols and the Health and Safety Plan developed previously for this project (Geomatrix, 1993c). Samples will be transported to a State-certified laboratory under chain-of-custody procedures. The laboratory will provide all sample containers and perform the required analyses by EPA- or DHS-certified methods. Water purged from the wells and generated during equipment cleaning will be temporarily contained onsite in a Baker tank (or equivalent). Disposal or discharge of this water by McKesson will be in accordance with applicable regulations.

7.1.2 Water-Level Data

Based on available data, it appears that the horizontal hydraulic gradient is oriented to the southwest with a magnitude of 0.005 ft/ft. Because the direction of the horizontal hydraulic gradient affects the proposed location of extraction wells and the magnitude of the gradient affects the flow rate required to achieve containment, it is important to determine the effect, if any, of seasonal variation on gradient direction and magnitude. Geomatrix is now measuring water levels in onsite monitoring wells on a regular basis. Water levels in all monitoring wells, except the MW-17 cluster, are measured monthly to the nearest 0.01 foot according to Geomatrix protocols using an electronic water level sounder. Water levels in the MW-17 well cluster are measured every two hours and recorded automatically by in situ data loggers equipped with pressure transducers.

Water-level measurements will be compared with historical data to confirm the direction of horizontal and vertical hydraulic gradients, and to determine if there are seasonal variations. Based on the results of these data, the input parameters to the hydraulic model will be revised.

7.2 INSTALLATION AND TESTING OF AN EXTRACTION WELL

The design of the IRM requires refined estimates of the extraction rate necessary to achieve containment and chemical analyses of the extracted groundwater. The extraction rate is based on the transmissivity of the A_1 zone, which has been estimated using data generated by others (Section 4.2). Although chemical data will be available from site monitoring wells (Section 7.1.1), it is prudent to collect samples from the extraction well during a pump test to confirm the aggregate chemical makeup of water produced from the well.

To collect the required hydraulic and chemical data, it is necessary to install, develop, and test an extraction well at the site. Extraction well EW-1 will be installed at the approximate location shown in Figure 10. The extraction well will be drilled, installed, developed, and tested in accordance with Geomatrix protocols and the Health and Safety Plan previously developed for this project (Geomatrix, 1993c). Geomatrix will obtain required permits prior to fieldwork. The pilot boring of the well will be continuously cored to provide stratigraphic information and data for well intake (screen slot-size and filter pack) design. The pilot boring will be drilled to approximately 80 feet bgs. After review of the core, the pilot boring will be reamed to a borehole diameter sufficient for installation of the well casing, screen, and annular fill. The well will be screened across the entire thickness of the A_1 zone. The well casing and screen will be of sufficient diameter to house the necessary pump. The borehole annulus will be grouted (sealed) in accordance with State and local requirements. A preliminary well design is shown on Figure 12. The well will be developed no less than 48 hours after installation by a combination of surging, bailing, and overpumping.

Drilling and development residuals, such as soil cuttings and purge water, will be temporarily contained onsite in tanks, roll-off bins, and/or drums. These residuals will be disposed of offsite by McKesson in accordance with applicable regulations.

The constant-discharge rate aquifer test will be conducted in accordance with Geomatrix protocols. The well will be pumped for approximately 24 hours at an estimated flow rate of at least 60 gpm. Drawdown and recovery will be measured in the pumping well and in several onsite monitoring wells. The groundwater produced during the test will be contained onsite in 20,000-gallon Baker tanks (or equivalent). Samples of the produced water contained in the tanks will be collected and analyzed after the test. The water will be properly discharged (after treatment, if necessary) or hauled offsite for disposal, depending on the analytical results, in accordance with applicable regulations.

Groundwater samples will be collected from the discharge of EW-1 at the end of the 24-hour test. Samples collected from this well will be analyzed for the same constituents identified for A_1 zone wells in Section 7.1.1.

7.3 SELECTION AND DESIGN OF IRM TREATMENT OPTION

This section describes the process by which the optimal treatment option will be identified from among the three viable treatment options described in Section 5 of this report. This process is presented schematically in Figure 13.

Based on our preliminary evaluation, Option 3, which comprises two air strippers in series, appears to have the lowest operating cost. However, the additional data described in Sections 7.1 and 7.2 must be collected and analyzed before it can be concluded that this is the optimal treatment option. Option 3 assumes that 1 lb/day of acetone can be discharged in the off-gas to the atmosphere and that up to 1 ppm of acetone can be discharged in the effluent to either the storm drain or sewer. These levels of permitted discharges must be verified with the SCAQMD, the RWQCB, and the City of Sante Fe Springs.

If the assumptions of both the influent characteristics and the discharge limits are appropriate, then Option 3 remains the best option and would likely be selected as the treatment system. If, however, the mass in the influent is higher than expected, or the discharge limits are more restrictive, then other options will be considered. For example, Options 2 and 4 can be designed to meet more stringent discharge limits.

Once the selection of the treatment and discharge options have been made, a design package will be developed. This will include the development of a process flow diagram to document the design basis and operating conditions of the process units, including specification of the off-gas treatment technology to be utilized. A Piping and Instrumentation Diagram (P&ID) will be developed to define all treatment system piping, tankage, valves, instrumentation, and the control and alarm parameters to be used in plant operations. Finally, an equipment layout drawing will be prepared to site the treatment area on the property and to position the major pieces of equipment within the treatment area.

7.4 ESTIMATED SCHEDULE

Figure 14 presents an estimated schedule for the additional field investigations, analyses, and design work described in the preceding sections. The schedule is subdivided according to the following tasks:

Task	Description
1	Sampling and Analysis of Existing Monitoring Wells
2	Extraction Well Installation and Testing
3	Analysis of Aquifer Test Data
4	Design of Extraction Well Network
5	Discharge Negotiations
6	Selection and Design of Treatment System
7	Preparation of IRM Design Report

As shown in Figure 14, data collection activities at existing groundwater monitoring wells are already underway, and groundwater sampling from these wells will be conducted upon review and approval of this report by DTSC. A groundwater extraction well will be installed and aquifer testing performed in August 1995. The hydraulic and chemical data from these activities will be used to refine the design basis of the IRM. Evaluation of discharge limits will be started in June 1995, and selection of the groundwater treatment alternative will be made upon refinement of the IRM design basis. The work will culminate in the delivery of the design report to DTSC in December 1995, assuming DTSC review and approval of this report is completed by 1 July 1995.

7.5 IRM DESIGN REPORT

The design report will document the technical work accomplished during the design phase of the project, which is scheduled from June 1995 to December 1995. Included in the report will be chemical and hydraulic results from sampling and analysis of the existing monitoring wells, results from the installation and aquifer test of the new extraction well EW-1, update of the computer modeling and design of the extraction well network proposed for the IRM, and design of the selected groundwater treatment system and water discharge method. Finally, the design report will present a work plan and schedule for the permitting and construction of the IRM facilities.